METHOD AND SYSTEM FOR DETERMINING POSITION OF TERMINAL BY USING LOCATION DETECTOR IN GPS SATELLITE-INVISIBLE AREA

Technical Field

The present invention relates to a terminal positioning method and system by using a plurality of location detectors (LDs) in a global positioning system (GPS) satellite-invisible area; and, more particularly, a terminal positioning method and system in which each LD is allowed to transmit a plurality of LD pilot signals, which are generated by adding preset offsets to positioning pseudo noise codes predetermined in a code division multiple access (CDMA) system, respectively, thereby separating LD pilot signal receiving areas, at which LD pilot signals are received, from a GPS satellite-invisible area.

Background Art

Since an internet communication service represented as the World Wide Web was highlighted, the internet communication service has brought an overwhelming change to human life from all viewpoints including the social, economic and political viewpoints. The internet has been currently recognized as a portion of the human life so that it is impossible to imagine life without the internet. Therefore, the super-highway communication network has been

largely prevailed to provide various communication services under the better environment.

Also, in order to provide communication services capable of overcoming the spatial constraints, a plurality of companies have recently developed technologies for use in the wireless internet. The wireless internet service represents a service for providing internet content through the mobile communication network. The wireless internet service is an enhanced personalization service resulted from the usage of individual terminals and, therefore, a service which may provide the specific information to the subscriber in spite of the subscriber's mobility. In particular, a location based services (LBS) among various wireless internet services has been currently spotlighted.

The LBS represents a communication service for determining the position of various potable terminals such as cellular phone, personal digital assistant (PDA) and notebook personal computer and providing supplementary information which is specific to the position of the terminals. As the mobile communication technology, the internet technology, the potable terminal technology, the information processing technology such as the geographical information system (GIS), the global positioning system (GPS) and the intelligent transport system (ITS), various content-related technologies have been gradually integrated, the LBS is expected to create explosive demand.

In order to use such LBS, it is necessary to determine the position of a wireless communication terminal. The technology for determining the position of wireless communication terminal is called as a position determination technology (PDT), which breaks down mainly into a network-based type in which base station receipt signals are used and a handset-based type in which GPS signals are used. Recently, a hybrid type has been developed in which both the types are combined to enhance the positioning accuracy.

The network-based type has an advantage in that no additional cost for developing a new cellular phone is required since there is no need for employing new module in the existing cellular phone, whereas it has an disadvantage of a lower precision in that its positioning error reaches roughly 500 meters to several kilometers depending on the cell size of a wireless base station or a position scheme. Accordingly, the handset-based type using the GPS signals becomes more and more popular in determining the position by using the wireless communications.

Fig. 1 is a block diagram for schematically showing a terminal positioning system 100 by using GPS.

The terminal positioning system 100 using the GPS includes GPS satellite constellation 110, a mobile communication terminal 120, a base transceiver station (BTS) 130, a base station controller (BSC) 140, a mobile switching

center (MSC) 150 and a position determination entity (PDE) 160.

The GPS is a satellite navigation system used for determining the position of any part on the Earth by using 24 GPS satellites 110 which orbit the earth at an altitude of about 20,000 kilometers. The GPS uses radio waves of the 1.5 GHz band and has a control center such as a control station on the ground to collect information transmitted from the GPS satellites and to synchronize signals communicated with the GPS satellite constellation 110.

The GPS satellite constellation 110 is used to detect the position of each mobile communication terminal 120 in the GPS. The GPS satellite constellation 110 is provided with 24 satellites for successively transmitting navigation data, required to calculate the position of the mobile communication terminal 120, to the mobile communication terminal 120 through a carrier wave, wherein 21 satellites are used to perform the navigation process while 3 satellites are provided as extra satellites.

Generally, a triangulation survey has been used to determine a specific position with the GPS. In order to determine the position with the GPS, at least four GPS satellites 110 are required, wherein three satellites perform the triangulation survey and the other satellite is used as an observatory satellite for measuring timing error. Specifically, since the respective positions of three

satellites have previously been recognized in the GPS, the distances between the satellites and a GPS receiver should be measured to perform the positioning process of the GPS receiver. An interval between a transmission time at which each satellite transmits a radio wave and a reception time at which the GPS receiver receives the transmitted radio wave may be used to calculate a distance between each satellite and the GPS receiver. The interval calculated as described above is called as a wave transfer interval, which may be multiplied by the speed of light to calculate the distance between each satellite and the GPS receiver.

The mobile communication terminal 120 incorporates a GPS receiver and so on for receiving the navigation data from the GPS satellites 110. The BTS 130, the BSC 140 and the MSC 150 perform other functions such as GPS clock distribution and GPS data transmission/reception as well as the conventional call processing function.

The PDE 160 receives the position information such as the latitudinal and longitudinal coordinate of the mobile communication terminal 120 from the mobile communication terminal 120, calculates the position of the mobile communication terminal 120 and transmits the calculated position information to a location based service (LBS) platform (not shown) from which various location based services are provided.

Such positioning method using the GPS has advantages in that everyone may use the method freely, there is no limitation on the number of users, the positioning process may be performed continuously in real time and it is possible to perform the position determination with a considerable precision.

Since, however, the position determination path may be a multi-path and the visible satellites may run short, the GPS positioning method has a disadvantage in that there is a limitation on the position determination capability, specifically, downtown. Further, it is almost impossible to perform the position determination in a satellite-invisible area in which it is impossible to watch any satellite, e.g., inside a tunnel or a building or underground a building (there is no radio wave to be arrived therein), and a larger error through the position determination may be generated depending on the satellites constellation shown from the GPS receiver. Also, a TTFF (Time To First Fix), which is a lead time required for the GPS receiver to determine its position for the first time, is sometimes taking about several minutes to several ten minutes or more, it may be inconvenient to the location based wireless internet users.

Disclosure of the Invention

It is, therefore, an object of the present invention to provide a terminal positioning method and system in which each LD is allowed to transmit a plurality of LD pilot signals, which are generated by artificially adding preset offsets to positioning pseudo noise codes predetermined in a code division multiple access (CDMA) system, respectively, thereby separating LD pilot signal receiving areas, at which LD pilot signals are received, from a GPS satellite-invisible area.

In accordance with an aspect of the present invention, there is provided a terminal positioning method in a global positioning system (GPS) satellite-invisible area in a code division multiple access (CDMA) mobile communication network by using a terminal, a plurality of location detectors (LDs) for generating and sending offsets, a position determination entity (PDE) for controlling a position determination of the terminal and an LD mapping server including a position information database, comprising the steps of: (a) allowing the terminal which received a positioning request to obtain a reference pilot signal of a base transceiver station or a repeater and LD pilot signals generated from the location detectors; (b) transmitting information on the reference pilot signal or the LD pilot signals to the PDE by using a pilot strength measurement message (PSMM) if the reference pilot signal or the LD pilot signals are received with a strength not smaller than a predetermined value; (c)

calculating a chip-based pseudo noise code phase from the PSMM transmitted to the PDE; (d) transmitting the pseudo noise code phase to the LD mapping server if the pseudo noise code phase calculated at step (c) is a phase of one of positioning pseudo noise codes allocated for the position determination; and (e) obtaining position information of the terminal by using the pseudo noise code phase transmitted to the LD mapping server.

In accordance with another aspect of the present invention, there is provided a terminal positioning system in a global positioning system (GPS) satellite-invisible area, comprising: a plurality of location detectors (LDs) for adding preset offsets to positioning pseudo noise codes predetermined in a code division multiple access (CDMA) mobile communication network, to generate and send LD pilot signals; a terminal for obtaining a reference pilot signal of a base transceiver station or a repeater and the LD pilot signals if a positioning request is received and, for transmitting a pilot strength measurement message (PSMM) in which information on the reference pilot signal or the LD pilot signals is added if the reference pilot signal or the LD pilot signals are received with a strength not smaller than a predetermined value; a position determination entity (PDE) for calculating a chip-based pseudo noise code phase from the PSMM received from the terminal and, if the calculated pseudo noise code phase is a phase of one of

positioning pseudo noise codes, transmitting the calculated pseudo noise code phase; and a LD mapping server for generating position information of the terminal by using the pseudo noise code phase received from the PDE.

Brief Description of the Drawings

The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram for schematically illustrating a conventional global positioning system (GPS) terminal positioning system by using a GPS;

Fig. 2 schematically illustrates a principle for differentiating respective base stations from each other by using a short pseudo noise code;

Fig. 3 is a block diagram for schematically illustrating a terminal positioning system by using a plurality of location detectors (LDs) in accordance with a preferred embodiment of the preferred embodiment;

Fig. 4 illustrates an example for establishing a unique identifier to each of the LDs in accordance with a preferred embodiment of the present invention;

Fig. 5 schematically represents an inner construction of a location detector in which a unique identifier is

generated for using a pilot strength measurement message (PSMM) in accordance with a preferred embodiment of the present invention; and

Fig. 6 is a flow chart for illustrating a terminal positioning process by using the terminal and the LDs.

Best Mode for Carrying Out the Invention

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. Here, like reference numerals represent like parts in various drawings. Further, it is notable that detailed description of known parts or functions will be omitted if there is a concern that the description of such parts or functions would render the technical essence of the present invention obscure.

The code division multiple access (CDMA) mobile communications use a Walsh code, a long pseudo noise code and a short pseudo noise code for channel distribution, voice coding and spread spectrum. The Walsh code is a orthogonal spreading code used to allow a mobile communication terminal to identify respective channels transmitted by the base stations through a forward channel, and the long pseudo noise code is used to allow a base station to identify respective subscribers through a reverse channel. Further, the short pseudo noise code is used to

allow a mobile communication terminal to identify respective base stations.

Fig. 2 is a schematic diagram in which the short pseudo noise code is used to allow to identify respective base stations.

The short pseudo noise code uses the orthogonal spreading, and, in the CDMA mobile communications, temporal offsets of such short pseudo noise code are used to distinguish the respective base stations from each other. Since each base station and its neighboring base stations use the same frequency in the CDMA mobile communications, the temporal offsets of the short pseudo noise code may be used to distinguish each base station from its neighboring base stations. In other words, each base station has a code generation timing which is temporally different from those of its neighboring base stations based on a universal time coordinated (UTC) so that the base stations may be distinguished from each other. If an offset, i.e., a temporal displacement, between two neighboring base stations is too small, two neighboring base stations cannot be effectively distinguished from each other due to the multi-path fading. Therefore, there must be a sufficient offset between each base station and its neighboring base station.

As shown in Fig. 2, the short pseudo noise code in the 0^{th} base station is generated at the moment delayed by 10 x 64 chips with respect to the reference time, and the short

pseudo noise code in the 1st base station is generated at the moment delayed by 18 x 64 chips with respect to the reference time. The generation moment of such short pseudo noise code refers to the offset of the short pseudo noise code, and the base stations may be distinguished from each other depending on their different offsets.

The short pseudo noise code is continuously broadcasted through the pilot channel of the forward channel, whereas each terminal has a hardware (a short pseudo noise code generator) therein so that the terminal may receive a signal related with the short pseudo noise code from the base station and generate and transmit a short pseudo noise code which is identical with the short pseudo noise code included in the received signal. The generation period of the short pseudo noise code corresponds to about 26.67 msec and its generation clock is 1.2288 Mcps (mega chip per second).

Fig. 3 is a schematic block diagram for a terminal positioning system by using a plurality of location detectors in accordance with a preferred embodiment of the present invention.

As shown in Fig. 3, the terminal positioning system in accordance with the preferred embodiment of the present invention may include a terminal 300, a plurality of location detectors (LDs) 302, a repeater 304, a base transceiver station (BTS) 306, a base station controller

(BSC) 308, a mobile switching center (MSC) 310, an inter-working function (IWF) 312, a position determination entity (PDE) 314, a mobile positioning center (MPC) 316, a location based service (LBS) platform 318, an LD mapping server 320 and a position information database (DB) 322.

The terminal 300 in accordance with the preferred embodiment of the present invention opens its traffic if a positioning request for executing an LBS service such as "friend search service" is received. In this case, the terminal 300 acquires a reference pilot signal from the BTS 306 or the repeater 304 and a plurality of LD pilot signals inherent to the respective LDs 302. In this case, the reference pilot signal or each LD pilot signal should have its strength (i.e., field strength) not smaller than a predetermined value in order to be acquired by the terminal 300, wherein the predetermined value in the preferred embodiment of the present invention is substantially a pilot detection threshold (T_ADD). After the terminal 300 receives the reference pilot signal or each LD pilot signal having its strength not smaller than the T_ADD, the terminal 300 transmits the information on the received reference pilot signal or the received LD pilot signals through the BTS 306, the BSC 308, the MSC 310 and so on to the LD mapping server 320.

Further, for each pilot channel to be received, the terminal 300 transmits to the BTS 306 a phase of a pilot

signal which has a first arrival path with its strength not smaller than the T_ADD. Furthermore, for such pilot signals, the terminal 300 transmits to the BTS 306 the sum of receiving signal intensities of their multi-path components.

On the other hand, the terminal 300 in accordance with the preferred embodiment of the present invention is mounted with a GPS antenna and a GPS module(chip) so that the terminal is preferably selected from personal digital assistant (PDA), cellular phone, personal communication service (PCS) phone, hand-held personal computer, global system for mobile (GSM) phone, wideband CDMA (W-CDMA) phone, evolution data only (EV-DO) phone, evolution data and voice (EV-DV) phone, mobile broadband system (MBS) phone, and so on. The MBS phone represents a phone to be used in the fourth generation system at issue or under discussion.

It is preferred that each LD 302 in accordance with the preferred embodiment of the present invention generates LD pilot signals by artificially adding preset offsets to the positioning pseudo noise codes predetermined in the CDMA system and transmits the same.

In order to use the offsets of the short pseudo noise codes used to differentiate the BTSs 306 from each other, thereby determining a position in a building in which no GPS signal is received, several specific pseudo noise codes should be predetermined in the CDMA system. Each LD 302 in accordance with the preferred embodiment of the present

invention artificially adds specific offsets within 64 chips to the positioning pseudo noise codes predetermined in the CDMA system, thereby generating and sending the LD pilot signals. In accordance with the preferred embodiment of the present invention, several areas, in which the LD pilot signals are received, may be differentiated from each other by combining the LD pilot signals in which such offsets are added, so that the position in the building may be determined.

The LDs 302 in accordance with the preferred embodiment of the present invention add chip-based offsets within 64 chips to each of at least two positioning pseudo noise codes predetermined for positioning. Hereinafter, the conditions for assigning offsets for two positioning pseudo noise codes will be described.

If two positioning pseudo noise codes are PN1 and PN2, two LD pilot signals obtained by adding offsets to the respective positioning pseudo noise codes may be represented as PN1 + offset1 and PN2 + offset2, respectively, wherein PN1 and PN2 are different from each other. Since the maximum variation of each pseudo noise code corresponds to 64 chips, the difference between offset1 and offset2 is at most 128 chips. In the preferred embodiment of the present invention, the difference between the offset1 and the offset2 becomes a unique identifier (ID) for differentiating several LDs 302 from each other, the combination of the

offset1 and the offset2 must be determined in order that the difference between the offset1 and the offset2 is uniquely assigned. Also, considering the fading phenomenon generated by the multi path, the offset1 and the offset2 must have margins larger than a preset value.

In the meantime, the terminal 300 in accordance with the preferred embodiment of the present invention receive the reference pilot signal and the LD pilot signals, wherein the reference pilot signal has been spread by the repeater 304 through the BTS 306 and the LD pilot signals have been sent through the LDs 302. Since the LD pilot signals sent from the LDs 302 are simply used for the position determination, they are preferably transmitted with a weaker strength than that of the reference pilot signal actually used for the call traffic so as to be excluded from the active set. In other word, the strengths of the LD pilot signals transmitted from the LD 302 in accordance with the preferred embodiment of the present invention are not smaller than T_ADD and smaller than that of the reference pilot signal.

Fig. 3 show each LD 302 in accordance with the preferred embodiment of the present invention which is connected to the repeater 304 so that the reference pilot signal to be spread in the repeater 304 and the LD pilot signals to be sent from each LD 302 are transmitted to the terminal 300. However, the LD 302 in accordance with the

preferred embodiment of the present invention is also allowed to perform the spread function so that it may be installed within the building and so on apart from the repeater 304.

If the signals received by the BTS 306 or the terminal 300 are very weak, the repeater 304 in accordance with the preferred embodiment of the present invention extracts the weak signals, amplifies the extracted weak signals with a low noise amplifier and reradiates the amplified signals through a re-amplifying antenna, thereby supporting to transmit/receive the weak signal. As described above, the LD 302 in accordance with the preferred embodiment of the present invention may be constructed so as to have a complex configuration with such function of the repeater 304 incorporated.

The BTS 306 in accordance with the preferred embodiment of the present invention is a network endpoint apparatus to be directly communicated with the terminal 300 by the base-band signal processing, the fixed mobile substitution, the wireless signal transmission/reception and so on. The BTS 306 in accordance with the preferred embodiment of the present invention transmits the reference pilot signal and the pseudo noise codes, which are established for the position determination, to the repeater 304 and the LDs 302, respectively, and transmits to the BSC

308 the information on the reference pilot signal or the LD pilot signals received from the terminal 300.

The BSC 308 in accordance with the preferred embodiment of the present invention controls the BTS 306 and performs the functions associated with the RF (radio frequency) channel allocation/release for the terminal 300, the transmission power control between the terminal 300 and the BTS 306, the inter-cell soft/hard handoff decision, the transcoding/vocoding, the GPS clock distribution, the operation/maintenance of the BTS 306 and so on. The BSC 308 in accordance with the preferred embodiment of the present invention transmits to the MSC 310 the information on the reference pilot signal or the LD pilot signals received from the BTS 306.

In the meantime, the BSC 308 receives the information on the reference pilot signal and the LD pilot signals from the terminal 300 through the BTS 306. In this case, the process for transmitting the information on the reference pilot signal and the LD pilot signals from the terminal 300 to the BSC 308 is executed by using a pilot strength measurement message (PSMM) transmitted by the terminal 300. The PSMM is used to transmit a receiving power of the terminal to the CDMA mobile communication network in order to execute a power control or a hand-off of the terminal in the CDMA mobile communication network. The BSC 308 receives the PSMM transmitted from the terminal 300 through BTS 306,

extracts a pseudo noise code phase of the reference pilot signal and a pseudo noise code phase for each of the LD pilot signals from the PSMM, and transmits the extracted pseudo noise code phases to the PDE 314 through the MSC 310 and the IWF 312.

In the meantime, since the pseudo noise code phase of the reference pilot signal extracted from the PSMM transmitted by the terminal 300 has one chip resolution, the pseudo noise code phase of the reference pilot signal may be sufficiently used to detect the LD pilot signals. However, since the terminal 300 reports only one pilot signal component having the first arrival path for each pilot channel to be received, the unique identifier of each LD 302 should have a delay component for each pseudo noise code offset. The inner construction of each LD 302 in which the unique identifier of each LD 302 for using the PSMM in accordance with a preferred embodiment of the present invention is generated will be described with reference to Fig. 5.

The positioning system for the terminal 300 in accordance with the preferred embodiment of the present invention supports a synchronous and an asynchronous mode. The BTS 306 and the BSC 308 in the synchronous mode correspond to a radio transceiver subsystem (RTS) and a radio network controller (RNC) in the asynchronous mode, respectively.

The MSC 310 in accordance with the preferred embodiment of the present invention performs the management function capable of operating the mobile communication network effectively and the switching function for the call request of the terminal 300. In other words, the MSC 310 performs the basic and the supplementary service processing of the terminal 300, the subscriber's incoming and outgoing call processing, the location registration processing, the hand off processing, the linking function with other networks and so on. The MSC 310 of the IS-95 A/B/C system includes a plurality of subsystems having an access switching subsystem (ASS) for performing the distributed call processing, an interconnection network subsystem (INS) for performing the centralized call processing, a central control subsystem (CCS) for handling the centralized operation and maintenance function, a location registration subsystem (LRS) for storing and managing the information on mobile subscribers and so on.

The MSC 310 in accordance with the preferred embodiment of the present invention receives the information on the reference pilot signal or the LD pilot signals transmitted via the BTS 306 and the BSC 308 and transmits the same to the LD mapping server 320.

The IWF 312 executes an interfacing function for coupling the mobile communication network and the wire communication network including the internet, the public

switched telephone network (PSTN), the packet switched public data network (PSPDN) and so on. In other word, the IWF 312 in the preferred embodiment of the present invention executes an interfacing function between the CDMA mobile communication network and the LBS system and the LD mapping server 320.

The LBS system includes the PDE 314, the MPC 316 and the LBS platform 318 so that it provides a position-based service by using the positioning information on the terminal 300.

The PDE 314 in accordance with the preferred embodiment of the present invention calculates chip-based pseudo noise code phases from the information on the reference pilot signal or the LD pilot signals transmitted via the BTS 306, the BSC 308 and the MSC 310. The information on the reference pilot signal transmitted by the terminal 300 by using PSMM through the CDMA mobile communication network to the PDE 314 may include the pseudo noise code phases of the reference pilot signal, the strength of the reference pilot signal, the measurement error for the phase and so on. The information on the LD pilot signals may include the pseudo noise code phase of the LD pilot signals, the strength of the LD pilot signal, the measurement error and so on.

The pseudo noise code phase of the reference pilot signal and the pseudo noise code phase of the LD pilot

signals transmitted from the terminal 300 in accordance with the preferred embodiment of the present invention is measured and transmitted on a 1/16 chip basis. Accordingly, the PDE 314 divides the pseudo noise code phase of the reference pilot signal and the pseudo noise code phases of the LD pilot signals by 16 to calculate the chip-based pseudo noise code phase.

The PDE 314 in accordance with the preferred embodiment of the present invention determines if the pseudo noise code phase calculated on a chip basis is a phase for the positioning pseudo noise code and, if so, the PDE 314 transmits the calculated pseudo noise code phase to the LD mapping server 320.

The MPC 316 in accordance with the preferred embodiment of the present invention is linked to the PDE 314 so that the MPC 316 may perform the routing function for transmitting the position information and so on of the terminal 300, which is calculated in the PDE 314 and the LD mapping server 320, to a plurality of LBS platforms 318 which provides a plurality of location based services. The LBS platform 318 represents a kind of application server for providing location based services with various communication terminals.

The LD mapping server 320 in accordance with the preferred embodiment of the present invention uses the pseudo noise code phases received from the PDE 314 to

generate the position information on the terminal 300. The LD mapping server 320 in accordance with the preferred embodiment of the present invention includes the position information database 322, wherein the position information database 322 stores offset differences added to a plurality of LD pilot signals generated in each LD 302 as a database, wherein each offset difference corresponds to its position information including an address, a name, a floor or its representative shop of its corresponding building.

The LD mapping server 320 in accordance with the preferred embodiment of the present invention uses the pseudo noise code phase received from the PDE 314 to search a unique ID (identifier) of the LD 302 corresponding to its phase difference from the position information database 322 and processes the unique ID with its in-building information associated with its corresponding building, subway or so on to transmit the processed information to the PDE 314.

Fig. 4 illustrates an example for establishing a unique identifier of each LD 302 in accordance with the preferred embodiment of the present invention.

As shown in Fig. 4, the first location detector (LD1) transmits the LD pilot signals of PN510 + 10 chips and PN512 + 20 chips, whereas the second location detector (LD2) transmits the LD pilot signals of PN510 + 10 chips and PN512 + 30 chips. The PN510 and the PN512 are the positioning pseudo noise codes predetermined in the CDMA system, whereas

10chips, 20chips and 30chips are offsets generated artificially in the LDs 302. The unique ID of LD1 has the phase difference of 10 chips, i.e., 20 chips - 10 chips, whereas the unique ID of LD2 has the phase difference of 20 chips, i.e., 30 chips - 10 chips. In accordance with the preferred embodiment of the present invention, such identifiers are uniquely established for respective location detectors 302, so that each building, subway station or so on is provided with its corresponding location detector 302 in accordance with the preferred embodiment of the present invention and, therefore, it is possible to search the location in the satellite-invisible area.

Fig. 5 schematically represents an inner construction of each LD (302) in which a unique identifier for using a pilot strength measurement message (PSMM) is generated in accordance with a preferred embodiment of the present invention.

Referring to Fig. 5, each LD 302 includes a plurality of pseudo noise code generators (PN generators) 510 and 512 and a plurality of delay devices 520 and 522 for time delay which are connected to respective output ends of the pseudo noise code generators 510 and 512. The respective pseudo node code generators 510 and 512 generate pseudo noise codes which are different from each other, wherein offsets, e.g., PN offset 1 and PN offset 2, which are different from each other, are assigned to the respective pseudo noise codes.

As previously described in Fig. 3, since the terminal 300 reports only one pilot signal component having the first arrival path for each pilot channel to be received, the LD 302 adds a time delay component to each pseudo noise code assigned with a specific offset generated from each of the pseudo noise code generators 510 and 512, thereby generating an LD pilot signal. Accordingly, since each of the LD pilot signals generated from the LD 302 has one time delay component for its corresponding offset, the terminal 300 recognizes the received LD pilot signal as a pilot signal with the first arrival path and transmits the PSMM attached by the information on the received pilot signal. If two or more time delay components are added to each offset of the LD pilot signals transmitted from the LD 302, the terminal 300 can not recognize the received LD pilot signal as a pilot signal with the first arrival path but as a multi-path padding signal so that the received LD signal may not be included in the PSMM.

The pseudo noise codes, in which specific offsets attached by time delay components are assigned, respectively, are integrated in the integrator 530, thereby generating the LD pilot signal.

Fig. 6 is a flow chart for illustrating a terminal positioning process by using a terminal and a plurality of location detectors in accordance with the preferred embodiment of the present invention.

First, if a positioning request such as a friend search service is received, the terminal 300 is allowed to open the traffic in the CDMA mobile communication network by using the location based system (LBS). The terminal 300 obtains the reference pilot signal of the BTS 306 or the repeater 304 and the LD pilot signals generated from the LD 302 at Step S600.

It is determined if the reference pilot signal or each LD pilot signal obtained in the terminal 300 is not smaller than T_ADD at Step S602. The information on the reference pilot signal or the LD pilot signal not smaller than T_ADD is added to the PSMM and then transmitted to the PDE 314 at Step S604. The information transmitted on each pilot signal may include the pseudo noise code phase of the received pilot signal, the strength of the received pilot signal, the measurement error obtained in the phase measurement or so on.

The pseudo noise code in accordance with the CDMA technology standard ranges from 0 chip to 32767.9357 chips (about 32768 chips). Since each CDMA BTS uses the pseudo noise code phases separated by 64 chips from each other, the total pseudo noise codes ranges from 1 to 512. Since the terminal 300 measures and transmits the pseudo noise code phases of each pilot signal on a 1/16 chip basis, the pseudo noise code phase of the pilot signal is transmitted with a value which ranges from 0 to 524288 (32768 x 16). Accordingly, in order that the transmitted pseudo noise code

phase is used to calculate the chip-based pseudo noise code phase, the transmitted pseudo noise code phase must be divided by 16 and, in order to obtain its corresponding pseudo noise code, the pseudo noise code phase divided by 16 must be additionally divided by 64.

The PDE 314 uses the PSMM to calculate the chip-based pseudo noise code phase from the received information on the reference pilot signal or the LD pilot signals at Step S606. As described above, the chip-based pseudo noise code phase may be obtained by dividing the received pseudo noise code phase by 16.

At Step S608, the PDE 314 determines if there is a positioning pseudo noise code phase, allocated for the position determination, which is identical with each of the calculated chip-based pseudo noise code phases. If there is the identical positioning pseudo noise code phase, the PDE 314 transmits the positioning pseudo noise code phase to the LD mapping server 320 which has the position information database 322 at Step S610.

The LD mapping server 320 uses the pseudo noise code phases received from the PDE 314 to search a unique ID of the LD 302, corresponding to the difference between such pseudo noise code phases, from the position information database 322 and processes the unique ID with its in-building information associated with its corresponding building, subway or so on to transmit the processed

information to the PDE 314 at Step S612. The position information database 322 stores respective offset differences added to a plurality of LD pilot signals generated from the LD 302, wherein the respective offset differences correspond to the position information including its corresponding building address, name, floor number or representative shop, so that it is possible to search the location in the satellite-invisible area.

In the meantime, the terminal 300 transmits the pilot signal information by using the PSMM in accordance with the preferred embodiment of the present invention. Since the PSMM may be used only in the traffic channel, the terminal 300 which has not been in the traffic state forces to be shifted to the traffic state. Accordingly, the BSC 308 determines if the terminal 300 for positioning is in the traffic state or not. If it is determined that the terminal 300 is not in the traffic state, the BSC 308 forces the terminal to be shifted to the traffic state and transmits a pilot measurement request order (PMRO) message to the shifted terminal 300. If the terminal 300 receives the PMRO message through the BTS 306 or the repeater 304, the terminal 300 transmits to the BTS 306 the PSMM attached by the components of the reference pilot signal and the LD pilot signals.

Industrial Applicability

In accordance with the present invention as described above, even in the internal space or the underground at which the GPS signal is not be received or is so weak that it is difficult to determine the accurate position of the user, it is possible to detect the position of the mobile communication terminal without an additional system such as the GPS system.

Further, the present invention has an advantage capable of implementing effectively a nonessential position determination such as the floor distinction and its location based service therethrough by installing additional LD on a desired location in the internal space.

While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the present invention as defined in the following claims.